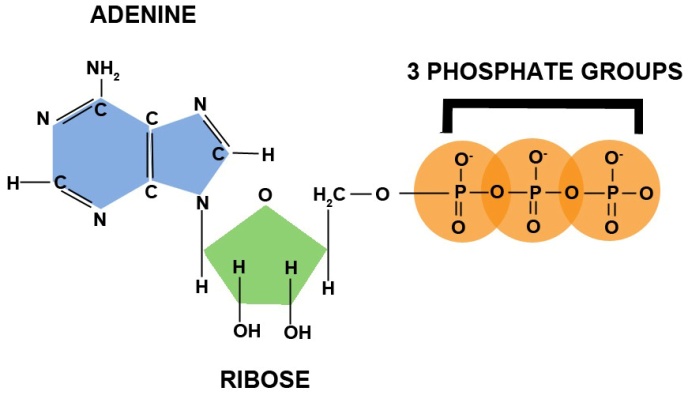
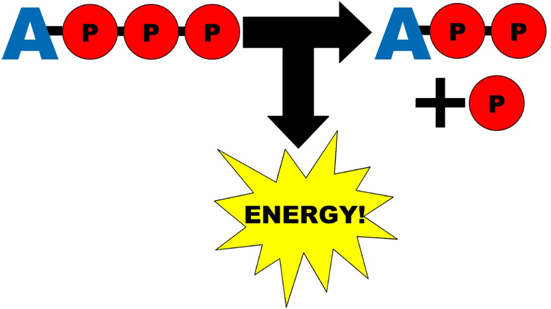
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**Unit 4 Review Packet: Cell Energy**

Ms. Ottolini, PreAP Biology

1. Describe the structure of ATP (adenosine triphosphate). Why do living organisms use ATP as the main energy storage molecule in the cell?

ATP is composed of an adenine nucleotide, a ribose sugar, and three phosphate groups. ATP is the main energy storage molecule in living organisms because it’s very easy to release energy from ATP. All you have to do is break the bond between the last two phosphate groups!

1. What is the difference between a heterotroph and an autotroph?

An autotroph can make its own glucose. A heterotroph must consume other organisms to obtain glucose.

1. Identify and describe the two types of autotrophs.

Photoautotrophs can make their own glucose using the energy from sunlight (process = photosynthesis). Chemoautotrophs can make their own glucose using energy from simple chemicals like hydrogen gas, hydrogen sulfide, or methane (process = chemosynthesis).

1. Why are photosynthesis and respiration often thought of as a cycle?

The products of photosynthesis are the reactants of respiration (and vice versa).

1. In what cell parts (i.e. organelles) of eukaryotic cells do photosynthesis and cellular respiration take place?

Photosynthesis takes place in the chloroplast and cellular respiration takes place in the mitochondrion.

1. What is the equation for cellular respiration? (In words and chemical formulas!)

**Words:** Glucose + Oxygen 🡪 ATP + Carbon Dioxide + Water

**Chemical Formulas:** C6H12O6 + 6O2 🡪 ATP + 6CO2 + 6H2O

1. What is the main goal of cellular respiration?

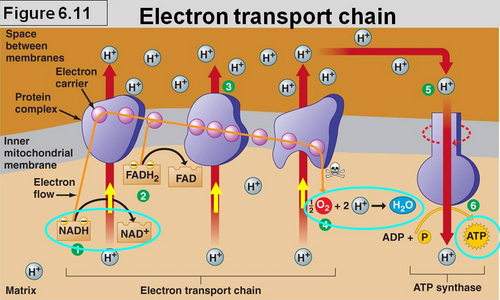
The goal of cellular respiration is to use the energy stored in the chemical bonds within the glucose molecule to create ATP.

1. What are the three steps of cellular respiration, what is the goal of each step, and where does each step occur within the cell or mitochondrion?

|  |  |  |
| --- | --- | --- |
| **Step Name** | **Goal** | **Location** |
| Glycolysis | Glucose is broken down into 2 pyruvate molecules, a small amount of ATP and NADH are made | Cytoplasm of the cell |
| Krebs Cycle | Pyruvate is broken down into CO2, a small amount of ATP is made, and a lot of NADH is made | Matrix of the mitochondrion |
| Electron Transport Chain | Use the energy from the electrons carried by NADH to make ATP | Inner membrane of the mitochondrion |

1. In what step of cellular respiration is the most ATP created?

The electron transport chain.

1. Explain (step-by-step) the process that is occurring in the image to the right. *(Hint: this is an image of the electron transport chain in cellular respiration.)*
2. NADH drops off high-energy electrons to membrane proteins in the inner mitochondrial membrane.
3. Membrane proteins take energy from electrons to pump H+ ions from the matrix to the intermembrane space (i.e. the space between the outer and inner mitochondrial membranes).
4. The buildup of H+ ions in the intermembrane space creates a concentration gradient across the inner mitochondrial membrane. H+ “wants” to flow down its concentration gradient from a high concentration in the intermembrane space to a low concentration in the matrix.
5. The only way that H+ can flow down its concentration gradient is by flowing through the ATP synthase protein. As H+ ions move through the ATP synthase protein, it causes the protein to turn and squish ADP and P that are floating around in the matrix together to make ATP.
6. Explain how the following sequence represents the energy changes that occur during cellular respiration: Food 🡪 glucose 🡪 NADH 🡪 ATP.

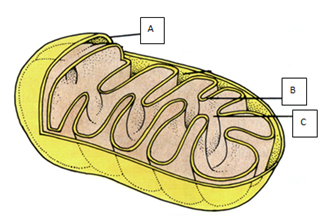
Foods are broken down into their fats, sugars, and proteins. Sugars like glucose give high energy electrons to NADH during glycolysis and the Krebs cycle. These electrons can be used during the electron transport chain to make ATP.

1. Compare / contrast aerobic and anaerobic respiration (aka fermentation). Which type of respiration makes more ATP?

Aerobic respiration requires oxygen and anaerobic respiration does not. Aerobic respiration makes more ATP.

1. Explain the difference between the two types of anaerobic respiration and identify the organisms that use these types of anaerobic respiration.

Lactic acid fermentation makes lactic acid as a waste product. This happens in human muscle cells and certain types of bacteria. Alcoholic fermentation makes ethyl alcohol and carbon dioxide as a waste product. This happens in yeast cells and certain types of bacteria.



1. Identify the parts labeled on the mitochondrion pictured to the right.

A = Outer membrane

B = Inner membrane (folds = cristae)

C = Matrix

1. What is the equation for photosynthesis? (In words and chemical formulas!)

**Words:** Carbon Dioxide + Water + Light Energy 🡪 Glucose + Oxygen

**Chemical Formulas:** 6CO2 + 6H2O + Light Energy 🡪 C6H12O6 + 6O2

1. What is the main goal of photosynthesis?

The goal of photosynthesis is to use the energy from sunlight to create glucose.

1. What are the two steps of photosynthesis, what is the goal of each step, and where does each step occur within the chloroplast?

|  |  |  |
| --- | --- | --- |
| **Step Name** | **Goal** | **Location** |
| Light Reactions (AKA light-dependent reactions) | Use the energy from sunlight to make ATP and NADPH. | Thylakoid membrane |
| Calvin Cycle (AKA light-independent reactions or dark reactions) | `  Use the energy from ATP and NADPH to make glucose from carbon dioxide. | Stroma |

1. Describe how chlorophyll is used during the light reactions of photosynthesis.

Chlorophyll in the thylakoid membrane absorbs sunlight. Some of the electrons from the chlorophyll molecule are “excited” by the sunlight and passed to NADPH.

1. Describe how water is used during the light reactions of photosynthesis.

The energy from sunlight splits water into oxygen gas (O2), H+, and electrons. The electrons are used to replace the electrons lost by the chlorophyll molecule.

1. How / when is oxygen gas produced during photosynthesis?

Oxygen gas is produced during the light reactions. (For how it is produced, see #19.)

1. How / when is carbon dioxide gas used during photosynthesis?

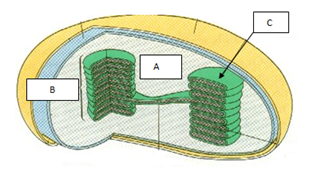
Carbon dioxide (CO2) is used during the Calvin cycle. The energy from ATP and electrons carried by NADPH is used to convert CO2 to glucose.

1. How is NADPH created during the light reactions and used during the dark reactions of photosynthesis?

NADPH “steals” excited electrons from chlorophyll and carries them to the dark reactions (AKA Calvin cycle), where the energy from these electrons is used to convert CO2 to glucose.

1. How could you measure the rate (amount over time) of photosynthesis in a plant? *(Hint: There are several correct answers to this question!)*

You could measure the rate of carbon dioxide use (consumption) or the rate of oxygen gas production.



1. Identify the parts labeled on the chloroplast pictured to the right.

A = Stroma

B = Granum

C = Thylakoid

1. How did mitochondria and chloroplasts become part of eukaryotic cells through endosymbiosis? Provide two pieces of evidence to support the idea that mitochondria and chloroplasts were once free-living organisms.

During endosymbiosis, a large prokaryotic cell “swallowed” a small prokaryotic cell. The small prokaryotic cell eventually became an organelle (i.e. a chloroplast or mitochondrion) for the larger cell.

The evidence that supports the idea that mitochondria and chloroplasts were once free-living organisms includes the presence of a double membrane, their own DNA, and their own ribosomes.

1. How do plants take in water and transport water throughout their bodies? Why is water important in photosynthesis?

Plants take in water through their roots. Water moves by osmosis from a high concentration in the soil to a low concentration inside the root cells. Water is transported up the stem of the plant through a tube called the xylem by capillary action.

1. How do plants take in carbon dioxide and release oxygen?

Plants take in carbon dioxide and release oxygen gas through holes on the bottom of leaves called stomata.

1. Identify several factors that might INCREASE the rate of photosynthesis in plants.

Increased temperature, light, and amount of carbon dioxide / water might increase the rate of photosynthesis in plants.